

Radiotherapy: past and present

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SUMMARY

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Discovery of radioactive X-rays in 1895 by Wilhelm Conrad Roentgen marked the beginning of significant events in diagnostics and treatment of many diseases. The idea of using X-rays in treatment of malignant diseases was born the same year, when X rays were used for treatment of local relapse of breast cancer, upon initiative of medical student Emil Grubbe. This event was followed by important discoveries of radioactive elements. Marie and Pierre Curie discovered polonium and radium and were awarded the Nobel Prize for their discovery in 1903 and 1911. Their daughter, Irène Curie, joined their research on radioactivity and was awarded the Nobel Prize in 1935. The potentials of radiotherapy became increasingly exploited in treatment of oncological patients. The beginning of radiotherapy in Novi Sad dates from 1934 with the arrival of Dr. Nikola Vujić, a specialist in internal medicine and radiology, and when the first universal X-ray generator was installed and used for therapy. After the World War II, radiotherapy was modernized by purchasing modern devices: 4-valve multi-voltage device (Siemens) for deep radiotherapy and contact radiotherapy by Chaoul. Today, radiotherapy for oncological patients in Novi Sad complies with modern trends and protocols (conformal technique). It has the most advanced technical capacities used worldwide and it takes into account the therapeutical effects and patients' quality of life.

KEY WORDS: History of Medicine; History, 19th Century; History, 20th Century; X-Rays; Radiotherapy; Medical Oncology; Serbia

INTRODUCTION

While examining a woman with breast cancer 2,500 years ago, Hippocrates noticed an abnormality he named "karkinos" because of large veins that reminded him of crab's legs. Cancer, a painless, unrecognizable, and deadly disease has been treated under this name ever since. Until the 19th century, the only way to treat cancer was surgical treatment. Radioactive treatment was introduced in therapy after discovery of "new rays" whilst introduction of chemotherapy in 1909 can be credited to Paul Ehrlich (1, 2). Introduction of ionizing radiation in treatment of cancer began immediately after discovery of X-rays in the 19th century, more precisely in 1895 (WC Roentgen) and discovery of radium by Pierre and Marie Curie in 1898. These two initial discoveries served as the basis for further innovations aiming to improve radiation treatment of patients, which we use at present time (3).

Knowledge of biology of cancer cells and effects of radiation on tissues and cells kept developing in the 20th century, and the use of all the supporting technologies brought us closer to the dream of all radiation oncologists (4, 5). The dream of each radiotherapist since 1896 to present time has been to: "Apply 100% of dosage to the target, 0% of dosage to risky organs, destroy 100% of cancer cells, and protect healthy cells" (J. P. Gerard) (6).

RADIOTHERAPY AT THE END OF THE 19TH CENTURY

On November 8, 1895, in his laboratory in Wurzburg, W. C. Roentgen (Figure 1) registered the new type of penetrating rays. He spent seven weeks to follow working on his experiment and on December 26, 1895, took the very first picture of his wife's hand with a ring using what he called *the new rays*, creating the new famous roentgen picture (Figure 2) (1-3, 7).

Unlike well known and worldwide-recognized W. C. Roentgen and Pierre and Marie Curie (Figure 3 and 4), relatively little is known about Emil

Grubbe (1875-1960) (Figure 5), who first applied X-rays in therapeutic purposes, and Victor Despeignes (Figure 6), and Leopold Freund (Figure 7) who introduced X rays in practice (8-14).

X rays were discovered in 1895.



Figure 1. W. C. Roentgen



2. Hand of W. C. Roentgen's wife with a ring



Figure 3. Pierre Curie



Figure 4. Marie Curie



Figure 5. Emil Grubbe

It was already on January 12, 1896, only 17 days from publishing Roentgen's discovery, that Emil Grubbe applied X-rays to irradiate a female patient suffering from locally advanced breast cancer and recorded palliative effect, but he did not publish the results until much later.

Emil Grubbe, a son of German immigrants in the United States and a person quite unusual for that time and place, worked from the age of 13, 10 hours a day, getting paid \$2 per week. At the age of 15, he decided to become a physician. His formal education was so limited that he first had to complete it, working as a night watchman at the same time. He entered Medical College of Chicago. Emil Grubbe, an extraordinary person, a passionate volcanologist and world traveler, visited each one of 10 then-active volcanoes in the world and witnessed several eruptions (San Pierre volcano of Mountain Pelée). Emil Grubbe's professional career lasted for a very long time despite his numerous health problems. He suffered from anemia, radiation dermatitis, which was probably radiation related, and his left arm was amputated in 1929. He died in 1960 as the result of multiple squamous carcinomas with metastases (13).

VICTOR DESPEIGNES (1866-1937)

Victor Despeignes was the first person to use radiation therapy in treatment of advanced stage of stomach cancer, convinced that cancer was a parasitic disease and that X-rays would have inhibitory effect on further tumor development. He documented his work by creating a report: "For eight consecutive days, I applied to the patient two sessions a day, with duration of half an hour. Eight days later, the patient no longer needed narcotics to relieve the pain, his general condition suddenly and dramatically improved and the volume of tumor reduced significantly." This attempt left no remarkable impression on his contemporaries, so Despeignes returned to working on bacteriological research (2).

LEOPOLD FREUND (APRIL 5, 1868 MISKOVICE – JANUARY 7, 1943 BRUSSELS)

Leopold Freund was a dermatologist and professor of radiology at the Medical University of Vienna. He was the first physician to use ionizing radiation for therapeutic purposes. In 1896, a year after discovery of X-rays and the same year that Antoine Henri Becquerel discovered radioactivity, Freund successfully treated a five-year-old patient in Vienna

suffering from hairy moles covering her whole back. The case was published in 1901. In 1903, he published the first textbook on radiation therapy. In 1938, he immigrated to Belgium, following the annexation of Austria by Germany (14).

20TH CENTURY

In Vojvodina, Dr. Dimitrije Nestorović, radiologist, arrived in Novi Sad from Belgrade in 1928. There are no available records about radiation treatments until 1934. Dr. Nikola Vujić (Figure 8), internal medicine and radiology specialist, improved this field of medicine and acquired one universal Siemens X-ray generator for the hospital and another for his private practice (Figure 9). At the same time, Dr. Sima Aleksić also had the same universal X-ray generator for his private practice (15).

In 1948, the General Hospital purchased a 2-valve X-ray generator for radiation therapy, device for contact therapy by Chaoul in 1950, and a 4-valve multivoltage Siemens for deep radiation therapy in 1951.

At that point of time, there were only two radiologists engaged in radiotherapy: Dr. Nikola Vujić and Dr. Aladar Vermeš, also a specialist in internal medicine and radiology.

In 1951, Dr. Vermeš published the first paper about his own experience. Siemens Stabilipan orthovoltage therapy device was acquired in 1955, which represented a very good and modern device at that point of time.

The year of 1967 was particularly important for radiotherapy in Vojvodina. It was the year of introducing brachytherapy – the process of treating gynecological tumors. The first device for supervoltage radiation therapy (a cobalt bomb) was introduced the same year and it covered the entire transcutaneous radiotherapy in Vojvodina.

In 1983, radiotherapy became a constituent part of the Oncology Institute of Vojvodina, which purchased a modern linear accelerator for radiation treatment with photons and electrons (15).

TODAY

In the past decades, technological progress depended on improvement of computer and imaging techniques which nowadays allow us three-dimensional planning of treatments. CT, MRI, and PET scan are necessary and indispensable for good differentiation of tumor volume from healthy surrounding organs (16) in the process of radiotherapy planning.



Figure 6. Victor Despeignes



Figure 7. Leopold Freund



Figure 8. Dr. Nikola Vujić

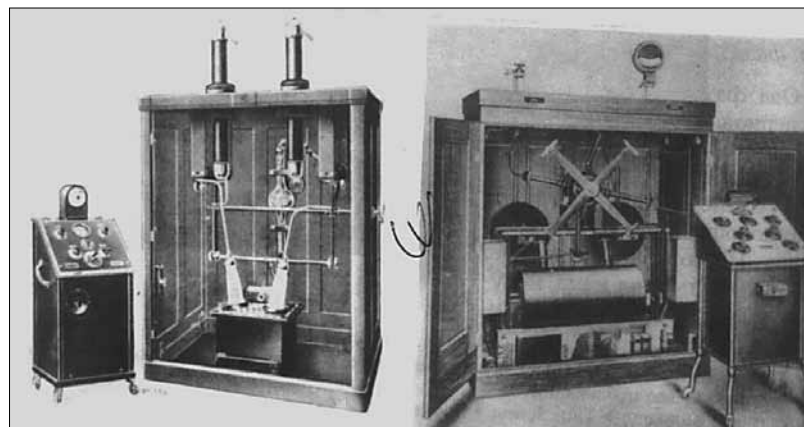


Figure 9. First X-ray generators in Vojvodina

A big step forward was made in the past decade by constructing a device with MLC (Multi Leaf Collimators) – small metal leaves of which each one can move independently from others, creating fields of various shapes and at the same time protecting the surrounding organs (Figure 10). Intensity-modulated radiotherapy (IMRT) concept had been described back in 1978, but it was not until the 90's that it was applied in practice, following improvement and development of computer equipment. Today, we are at the level of three-dimensional conformal radiotherapy (Figures 10 and 11).



Figure 10. VARIAN device for conformal radiotherapy

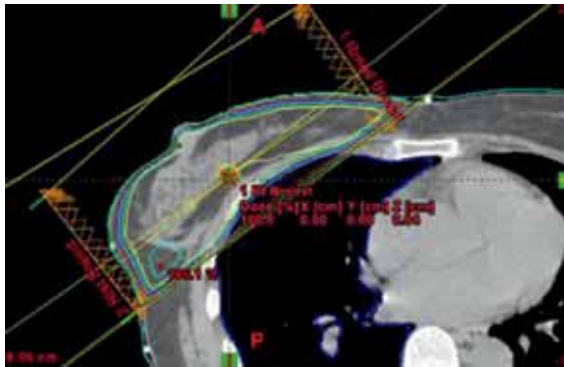


Figure 11. 3D plan for conformal breast radiation treatment

TOMORROW?

CALENDAR OF EVENTS

- 1895 – W.C. Roentgen in Wurzburg – discovery of X-rays
- 1895 – Emil Grubbe – first use of X-rays in treatment of relapse of breast cancer
- 1896 – Henri Becquerel – discovery of natural radioactivity
- 1896 – Leopold Freund – radiation of hairy moles of a five-year-old child
- 1897 – Thomson identifies electrons
- 1898 – Pierre and Marie Curie discover radium
- 1901 – Dr. Danlos – first therapeutic use of radium in brachytherapy for skin treatment

- 1903 – Dr. Senn and Pusey- first scientific description of radiotherapy effects to the lymph nodes
- 1930 – Institute Curie works on fractionation
- 1932 – James Chadwick discovers neutrons
- 1934 – Irène and Frédérique Joliot-Curie – discovery of artificial radioelements
- 1951 – Victoria Hospital London – cobalt installation
- 1951 – Stanford – first linear accelerator
- 1973 – G.N. Hounsfield – scanner construction
- 1990 – First use of scanner in IMRT radiation treatment planning

Conflict of interest

We declare no conflicts of interest.

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